

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, MEDIUM-POWER,
TYPES 2N497, 2N498, 2N656, AND 2N657

This specification is mandatory for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for NPN, silicon, medium-power transistors.

1.2 Physical dimensions. See figure 1 (TO-5).

1.3 Maximum ratings.

Types	P_T ^{1/} $T_A = 25^\circ \text{C}$	P_T ^{2/} $T_C = 25^\circ \text{C}$	V_{CBO}	V_{CEO}	V_{EBO}	T_{stg}
	<u>W</u>	<u>W</u>	<u>Vdc</u>	<u>Vdc</u>	<u>Vdc</u>	<u>°C</u>
2N497, 2N656	0.8	4	60	60	8	-65 to +200
2N498, 2N657	0.8	4	100	100	8	-65 to +200

^{1/} Derate linearly 4.6 mW/°C for $T_A > 25^\circ \text{C}$.

^{2/} Derate linearly 23 mW/°C for $T_C > 25^\circ \text{C}$.

1.4 Primary electrical characteristics. (At: $T_A = 25^\circ \text{C}$.)

h_{FE} $I_C = 50 \text{ mAdc}$ $V_{CE} = 10 \text{ Vdc}$		h_{FE} ^{1/} $I_C = 200 \text{ mAdc}$ $V_{CE} = 10 \text{ Vdc}$		$ h_{fe} $ $I_C = 30 \text{ mAdc}$ $V_{CE} = 30 \text{ Vdc}$ $f = 10 \text{ MHz}$	$V_{CE} \text{ (sat)}$ ^{1/} $I_C = 200 \text{ mAdc}$ $I_B = 40 \text{ mAdc}$	V_{BE} ^{1/} $I_C = 200 \text{ mAdc}$ $V_{CE} = 10 \text{ Vdc}$
2N497	2N656	2N497	2N656			
2N498	2N657	2N498	2N657			
Min.	10	20	12	30	1.5	0.1
Max.	40	100	36	90	10.0	2.0

^{1/} Pulsed (see 4.4.1).

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

FSC 5961

MIL-S-19500/74E

SPECIFICATION

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARDS

MILITARY

MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 General. Requirements shall be in accordance with MIL-S-19500, and as specified herein.

3.2 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein are defined in MIL-S-19500.

3.3 Design, construction, and physical dimensions. Transistor shall be of the design, construction, and physical dimensions shown on figure 1.

3.3.1 Lead material and finish. Lead material and finish shall be gold-plated Kovar. (Leads may be tin-coated if specified in the contract or order and it shall not be construed as adversely affecting the Qualified-product status of the device, or applicable JAN marking (see 6.2).

3.3.2 Terminal-lead length. Terminal-lead length(s) other than that specified on figure 1 may be furnished under contract or order (see 6.2) where the devices covered herein are required directly for particular equipment-circuit installation or for automatic-assembly-technique programs. Where other lead lengths are required and provided, it shall not be construed as adversely affecting the Qualified-product status of the device, or applicable JAN marking (see 6.2).

3.4 Performance characteristics. Performance characteristics shall be as specified in tables I, II, and III.

3.5 Marking. The following marking specified in MIL-S-19500 may be omitted from the body of the transistor at the option of the manufacturer:

- (a) Country of origin.
- (b) Manufacturer's identification.

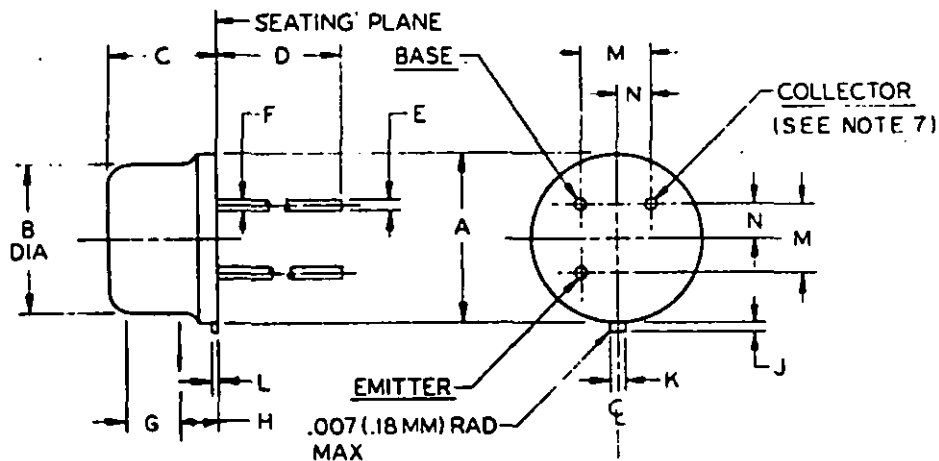
4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

4.2 Qualification inspection. Qualification inspection shall consist of the examinations and tests specified in tables I, II, and III.

4.3 Quality conformance inspection. Quality conformance inspection shall consist of groups A, B, and C inspections.

4.3.1 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table I.

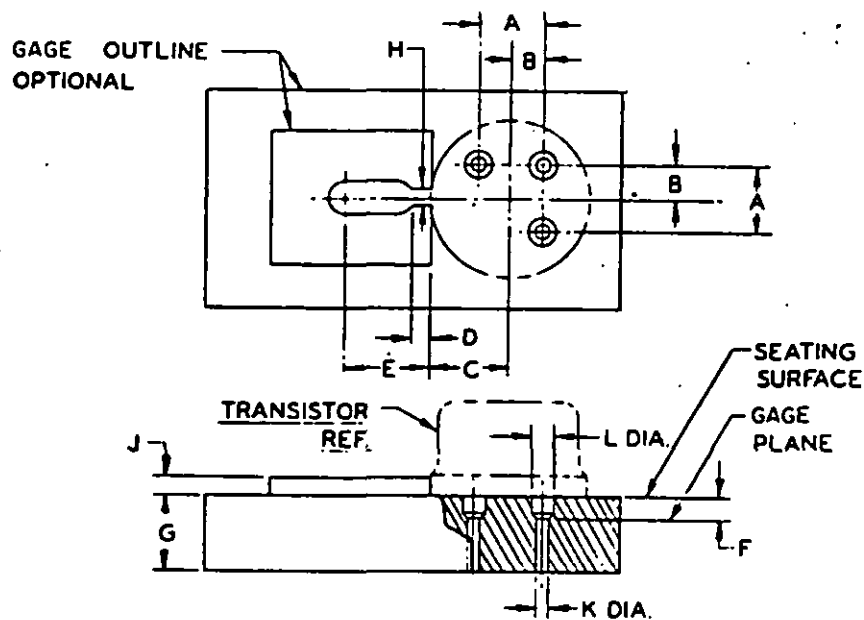


DIMENSIONS					NOTES
LTR	INCHES		MILLIMETERS		
	MIN	MAX	MIN	MAX	
A	.335	.370	8.51	9.40	
B	.305	.335	7.75	8.51	
C	.240	.260	6.10	6.60	
D	1.500	1.750	38.10	44.45	9
E	.016	.021	.41	.53	2,9
F	.016	.019	.41	.48	3,9
G	.100		2.54		4
H					5
J	.029	.045	.74	1.14	8
K	.028	.034	.71	.86	
L	.009	.125	.23	3.18	
M	.1414	Nom	3.59	Nom	6
N	.0707	Nom	1.80	Nom	6

NOTES:

1. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.
2. Measured in the zone beyond .250 (6.35 mm) from the seating plane.
3. Measured in the zone .050 (1.27 mm) and .250 (6.35 mm) from the seating plane.
4. Variations on dimension B in this zone shall not exceed .010 (.25 mm).
5. Outline in this zone is not controlled.
6. When measured in a gaging plane .054 +.001, -.000 (1.37 +.03, -.00 mm) below the seating plane of the transistor maximum diameter leads shall be within .007 (.18 mm) of their true location relative to a maximum width tab. Smaller diameter leads shall fall within the outline of the maximum diameter lead tolerance. Figure 2 preferred measured method.
7. The collector shall be internally connected to the case.
8. Measured from the maximum diameter of the actual device.
9. All 3 leads. (See 3.3.1 and 3.3.2).

FIGURE 1. Physical dimensions of transistor types 2N497, 2N498, 2N656 and 2N657. (TO-5).



LTR	DIMENSIONS			
	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.1409	.1419	3.58	3.60
B	.0702	.0712	1.78	1.81
C	.182	.199	4.62	5.05
D	.009	.011	.23	.28
E	.125 Nom		3.18 Nom	
F	.054	.055	1.37	1.40
G	.372	.378	9.45	9.60
H	.0350	.0355	.89	.90
J	.150 Nom		3.81 Nom	
K	.0325	.0335	.83	.85
L	.0595	.0605	1.51	1.54

NOTES:

1. The following gaging procedure shall be used: The use of a pin straightener prior to insertion in the gage is permissible. The device being measured shall be inserted until its seating plane is .125 \pm .010 (3.18 \pm .25 mm) from the seating surface of the gage. A spacer may be used to obtain the .125 (3.18 mm) distance from the gage seat prior to force application. A force of 8 oz \pm .5 oz shall then be applied parallel and symmetrical to the device's cylindrical axis. When examined visually after the force application (the force need not be removed) the seating plane of the device shall be seated against the gage.
2. The location of the tab locator, within the limits of dimension C will be determined by the tab and flange dimension of the device being checked.
3. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.

FIGURE 2. Gage for lead and tab location for transistor types 2N497, 2N498, 2N656 and 2N657.

4.3.2 Group B inspection. Group B inspection shall consist of the examinations and tests specified in table II.

4.3.3 Group C inspection. Group C inspection shall consist of the examinations and tests specified in table III. This inspection shall be conducted on the initial lot and thereafter every 6 months during production.

4.3.4 Group B and group C life-test samples. Samples that have been subjected to group B, 340-hours life-test, may be continued on test to 1,000 hours in order to satisfy group C life-test requirements. These samples shall be predesignated, and shall remain subjected to the group C 1,000 hour acceptance evaluation after they have passed the group B, 340-hour acceptance criteria. The cumulative total of failures found during 340-hour test and during the subsequent interval up to 1,000 hours shall be computed for 1,000-hour acceptance criteria (see 4.3.3).

4.4 Methods of examination and test. Methods of examination and test shall be as specified in tables I, II, and III.

4.4.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

4.4.2 Interval for end-point test measurements. End point tests shall be completed within the following time limitations after completion of the last test in the subgroup:

- (a) Qualification inspection: within 24 hours.
- (b) Quality conformance inspection: within 96 hours.

TABLE I. Group A inspection

Examination or test	MIL-STD-750		L T P D	Symbol	Limits		
	Method	Details			Min	Max	Unit
<u>Subgroup 1</u>			10				
Visual and mechanical examination	2071			---	---	---	---
<u>Subgroup 2</u>			5				
Breakdown voltage, collector to emitter 2N497, 2N656 2N498, 2N657	3011	Bias cond. D; $I_C = 250 \mu\text{Adc}$		BV_{CEO}	60 100	---	Vdc Vdc
Breakdown voltage, collector to emitter 2N497, 2N656 2N498, 2N657	3011	Bias cond. D; $I_C = 30 \text{ mAdc}$; pulsed (see 4.4.1)		BV_{CEO}	60 100	---	Vdc Vdc
Breakdown voltage, collector to base 2N497, 2N656 2N498, 2N657	3001	Bias cond. D; $I_C = 100 \mu\text{Adc}$		BV_{CBO}	60 100	---	Vdc Vdc
Breakdown voltage, emitter to base	3026	Bias cond. D; $I_E = 250 \mu\text{Adc}$		BV_{EBO}	8.0	---	Vdc

TABLE I. Group A Inspection - Continued

Examination or test	MIL-STD-750		L T P D	Symbol	Limits			
	Method	Details			Min	Max	Unit	
<u>Subgroup 2 - Continued</u>								
Collector to base cutoff current	3036	Bias cond. D	5	I_{CBO}				
2N497, 2N656		$V_{CB} = 50 \text{ Vdc}$			---	1.0	μAdc	
2N498, 2N657		$V_{CB} = 80 \text{ Vdc}$			---	1.0	μAdc	
<u>Subgroup 3</u>								
Forward-current transfer ratio	3076	$V_{CE} = 10 \text{ Vdc};$ $I_C = 50 \text{ mAdc}$	10	h_{FE}				
2N497, 2N498					10	40	---	
2N656, 2N657					20	100	---	
Forward-current transfer ratio	3076	$V_{CE} = 10 \text{ Vdc}; I_C = 200 \text{ mAdc};$ pulsed (see 4.4.1)		h_{FE}				
2N497, 2N498			10		12	36	---	
2N656, 2N657					30	90	---	
Collector to emitter voltage (saturated)	3071	$I_C = 200 \text{ mAdc}; I_B = 40 \text{ mAdc};$ pulsed (see 4.4.1)		$V_{CE}^{(sat)}$	0.1	2.0	Vdc	
Base emitter voltage (nonsaturated)	3066	Test cond. B; $I_C = 200 \text{ mAdc};$ $V_{CE} = 10 \text{ Vdc};$ pulsed (see 4.4.1)		V_{BE}	---	2.0	Vdc	
Magnitude of common-emitter small-signal short-circuit forward-current transfer ratio	3306	$V_{CE} = 30 \text{ Vdc}; I_C = 30 \text{ mAdc};$ $f = 10 \text{ MHz}$	10	$ h_{fe} $	1.5	10.0	---	
<u>Subgroup 4</u>								
High-temperature operation: Collector to emitter cutoff current	3041	$T_A = +150^\circ \text{ C}$ Bias cond. A; $V_{BE} = -1.5 \text{ Vdc}$		I_{CEX}				
2N497, 2N656		$V_{CE} = 60 \text{ Vdc}$			---	300	μAdc	
2N498, 2N657		$V_{CE} = 100 \text{ Vdc}$		---	300	μAdc		
Low-temperature operation: Forward-current transfer ratio	3076	$T_A = -55^\circ \text{ C}$ $V_{CE} = 10 \text{ Vdc}; I_C = 200 \text{ mAdc};$ pulsed (see 4.4.1)	10	h_{FE}				
2N497, 2N498					6	---	---	
2N656, 2N657				15	---	---		

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TABLE II. Group B inspection

Examination or test	MIL-STD-750		L T P D	Symbol	Limits		
	Method	Details			Min	Max	Unit
<u>Subgroup 1</u>			20				
Physical dimensions	2066	(See figure 1)		---	---	---	---
<u>Subgroup 2</u>			15				
Solderability	2026	Omit aging		---	---	---	---
Thermal shock (temperature cycling)	1051	Test cond. C		---	---	---	---
Thermal shock (glass strain)	1056	Test cond. A		---	---	---	---
Seal (leak-rate)	---	MIL-STD-202, method 112, test cond. C, procedure III; test cond. A for gross leaks		---	---	5×10^{-7}	atm cc/sec
Moisture resistance	1021			---	---	---	---
End points: (See 4.4.2.)							
Collector to base cutoff current	3036	Bias cond. D;		ICBO			
2N497, 2N656		V _{CB} = 50 Vdc			---	1.0	μ Adc
2N498, 2N657		V _{CB} = 80 Vdc			---	1.0	μ Adc
Forward-current transfer ratio	3076	I _C = 200 mAdc; V _{CE} = 10 Vdc; pulsed (see 4.4.1)		h _{FE}			
2N497, 2N498					12	36	---
2N656, 2N657					30	90	---
<u>Subgroup 3</u>			15				
Shock	2016	Nonoperating; 1500 G, 0.5 msec, 5 blows in each orientation: X ₁ , Y ₁ , Y ₂ and Z ₁		---	---	---	---
Vibration fatigue	2046	Nonoperating		---	---	---	---
Vibration, variable frequency	2056			---	---	---	---
Constant acceleration	2006	10,000 G; in each orienta- tion; X ₁ , Y ₁ , Y ₂ , and Z ₁		---	---	---	---
End points:							
(Same as subgroup 2)							
<u>Subgroup 4</u>			15				
Terminal strength (lead fatigue)	2036	Test cond. E		---	---	---	---
<u>Subgroup 5</u>			15				
Salt atmosphere (corrosion)	1041			---	---	---	---

TABLE II. Group B inspection - Continued

Examination or test	MIL-STD-750		L T P D	Symbol	Limits			
	Method	Details			Min	Max	Unit	
<u>Subgroup 5 - Continued</u>								
End points:								
(Same as subgroup 2)								
<u>Subgroup 6</u>								
High-temperature life (nonoperating)	1031	$T_{stg} = +200^{\circ} \text{ C};$ $t = 340 \text{ hrs (see 4.3.4)}$	7	---	---	---	---	
End points: (See 4.4.2.)								
Collector to base cutoff current	3036	Bias cond. D		I_{CBO}				
2N497, 2N656 2N498, 2N657		$V_{CB} = 50 \text{ Vdc}$ $V_{CB} = 80 \text{ Vdc}$			---	10 10	μAdc μAdc	
Forward-current transfer ratio	3076	$V_{CE} = 10 \text{ Vdc}; I_C = 200 \text{ mAdc};$ pulsed (see 4.4.1)	7	h_{FE}				
2N497, 2N498 2N656, 2N657					9.6 24	45 117	---	---
Breakdown voltage, col- lector to emitter	3011	Bias cond. D; $I_C = 30 \text{ mAdc};$ pulsed (see 4.4.1)		BV_{CEO}				
2N497, 2N656 2N498, 2N657					60 100	---	Vdc Vdc	
<u>Subgroup 7</u>								
Steady-state operation life	1026	$T_A = 25^{\circ} \text{ C}; P_T = 0.8 \text{ W};$ $V_{CE} = 40 \text{ Vdc}; t = 340 \text{ hours}$ (see 4.3.4)	7	---	---	---	---	
End points:								
(Same as subgroup 6)								

TABLE III. Group C inspection

Examination or test	MIL-STD-750		L T P D	Symbol	Limits		
	Method	Details			Min	Max	Unit
<u>Subgroup 1</u>			15				
Barometric pressure, reduced (altitude operation)	1001	Normal mounting; pressure = 8 mm Hg for 60 sec min		---	---	---	---

TABLE III. Group C Inspection - Continued

MIL-S-19500/74E

Examination or test	MIL-STD-750		L T P D	Symbol	Limits		
	Method	Details			Min	Max	Unit
<u>Subgroup 1 - Continued</u>							
Measurement during test:							
Collector to base cutoff current	3036	Bias cond. D;		I_{CBO}			
2N497, 2N656		$V_{CB} = 60 \text{ Vdc}$			---	100	μAdc
2N498, 2N657		$V_{CB} = 100 \text{ Vdc}$			---	100	μAdc
<u>Subgroup 2</u>							
High-temperature life (nonoperating)	1031	$T_{stg} = +200^\circ \text{ C}$ (see 4.3.4)	$\lambda = 10$	---	---	---	---
End points:							
(Same as subgroup 6 of group B)							
<u>Subgroup 3</u>							
Steady-state operation life	1028	$T_A = 25^\circ \text{ C}; P_T = 0.8 \text{ W}$ $V_{CE} = 40 \text{ Vdc}$ (see 4.3.4)	$\lambda = 10$	---	---	---	---
End points:							
(Same as subgroup 6 of group B)							
<u>Subgroup 4</u>							
Burnout by pulsing	3005	Prepulse cond. : $T_C = 25^\circ \text{ C}; V_{CE} = 0;$ $I_C = 0$	15	---	---	---	---
		Pulse cond. : $V_{CE} = 40 \text{ Vdc}; I_C = 0.1 \text{ Adc};$ $t_p = 60 \text{ sec, 1 cycle};$ $t_r \leq 6 \text{ sec}; t_f \leq 6 \text{ sec}$					
End points:							
(Same as subgroup 6 of group B.)							

5. PREPARATION FOR DELIVERY

5.1 See MIL-S-19500, section 5.

MIL-S-19500/74E

6. NOTES:

6.1 Notes. The notes specified in MIL-S-19500 are applicable to this specification.

6.2 Ordering data.

(a) Lead finish if other than gold-plated Kovar. (See 3.3.1.)

(b) Terminal-lead length if other than specified on figure 1. (See 3.3.2.)

6.3 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

6.4 Substitution criteria. The devices covered herein are interchangeable with the corresponding devices covered by the superseded MIL-S-19500/74D.

Custodians:

Army - EL

Navy - EC

Air Force - 11

Preparing activity:

Navy - EC

(Project 5961-0009-21)

Review activities:

Army - EL, MU, MI

Navy - EC

Air Force - 11, 17, 85

Code "C"

User activities:

Army - EL, SM

Navy - CG, MC, AS, OS

Air Force - 14, 19